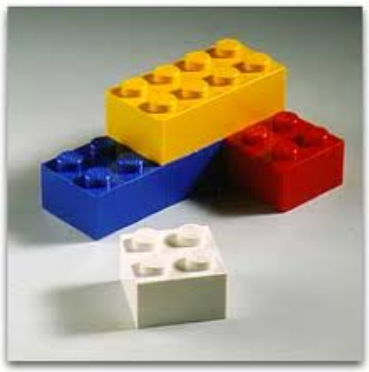
The Particle Theory of Matter

Over 2000 years ago a philosopher by the name of Democritus suggested that matter was made up of tiny particles too small to be seen.

Democritus claimed that particles were like the building blocks of matter.

THINK LEGO PIECES

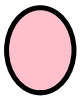


Principles of the Particle Theory of Matter

1. All matter is made up of tiny particles.

2. All particles of one substance are the same.

3. Particles are always moving. The more energy a particle has the faster they move.



4. Particles are attracted to one another. The closer the particles are together the stronger the attraction.

Classifying Matter

Matter can be broken down into two categories.

- Pure Substances - contain only one kind of particle.
  ex: Aluminum foil, Sugar

  - can be further classified as either:

    - Element - found on the periodic table

    - Compound - contain two or more elements

- Mixtures - contain at least two different pure substances.
  ex: Oreo cookie, Hot chocolate

  - can be further classified as either:

    - Heterogeneous mixture - can identify that more than one type of particle is composing it.

    - Homogeneous mixture - unable to identify individual components.

    - Solution - a homogenous mixture that is either a liquid or gas.

Classify The Following

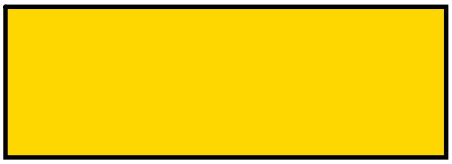
1. Ocean Water

2. Pizza

3. Garbage

4. Air

5. CO_2



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ATOMS

Scientists now call the Particles in the particle theory atoms.

Each element is made of only one kind of atom.

How many different atoms are there?

Molecules

- Atoms join together in combinations.

- When two or more atoms join together, a molecule is formed

- Molecules can contain two atoms or thousands of atoms
    - Water molecules have 2 hydrogen atoms and 1 oxygen atom
    - Methane gas molecules have one carbon atom and 4 hydrogen atoms
    - Acetic acid (vinegar) has 2 C, 2 O, and 4 H

Guess the Molecule

- I have 2 hydrogen atoms
- I have 1 oxygen atom

Guess the Molecule

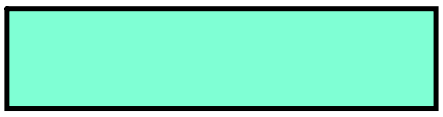
- I have 10 hydrogen atoms
- I have 2 oxygen atoms
- I have 7 carbon atoms
- I have 4 nitrogen atoms
- I am desired in the morning but avoid me in the evening
- Coke and Pepsi have me in common
- I am what makes coffee special

Guess the Molecule

- I have 6 hydrogen atoms
- I have 6 oxygen atoms
- I have 6 carbon atoms
- Everybody needs me
- I will keep colds away
- You can get me by eating oranges

Guess the Molecule

- I have 8 hydrogen atoms
- I have 4 oxygen atoms
- I have 9 carbon atoms
- I am used quite often by teachers, usually in pairs
- I am white in color
- You need water when you use me
- I will make you feel better



Chemical Symbols

- All elements on the periodic table have symbols that are recognized world wide.
- It does not matter which country or language, the element Iron is always identified by “Fe” and Oxygen is “O”.
- The names are not always the same but the symbols are. Fe is iron in Canada, fer in France and Fier in Romania.

Chemical Formulas

A chemical formula is a combination of symbols used to represent a specific compound. Every compound is represented by a separate chemical formula.

Examples:

- Calcium Carbonate (Chalk) - $CaCO_3$
- Sodium Chloride (Salt) - NaCl
- Acetylsalicylic acid (Aspirin) - $C_9H_8O_4$

Homework

Answer questions 1 - 5 on page 59

and

Questions 1,2, and 4 on page 61

Answering Questions about Molecules

By looking at the chemical formula of a molecule we can answer a variety of questions such as:

1. Which elements are required to construct the molecule?

2. How many atoms, of each element are required to construct the molecule?

3. How many atoms, in total, are required to construct the molecule?

4. What is the ration of each type of atom in the molecule?

5. What is the mass of each molecule?

Example

Aspirin: $C_9H_8O_4$

1. **Which elements are required to construct the molecule?**

   C = Carbon H = Hydrogen O = Oxygen

2. **How many atoms, of each element are required to construct the molecule?**

   C = 9 H = 8 O = 4

3. **How may atoms, in total, are required to construct the molecule?**

   9 + 8 + 4 = 21 atoms in total

4. **What is the ratio of each type of atom in the molecule?**

   C = 9/21 H = 8/21 O = 4/21

5. **What is the mass of each molecule?**

(atomic mass C) x 9	12.01 x 9	108.09
(atomic mass H) x 8	1.01 x 8	8.08
(atomic mass O) x 4	16.01 x 4	64.04

TOTAL = 180.21

EXAMPLE 2

Theobromine (Chocolate): $C_7H_8N_4O_2$

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Practice

1. Identify (as elements or compounds) each of the following molecules:
   a) carbon dioxide
   b) carbon monoxide
   c) oxygen
   d) ozone
   e) nitrogen

2. Answer the five molecule questions for the following compounds.
   a) Sugar: $C_6H_{12}O_6$
   b) Vinegar: CH_2COOH

Combining Capacity

The ability of one element to combine with another element is called the **combining capacity**.

Combining capacity is similar to the number of connections that an atom can make.

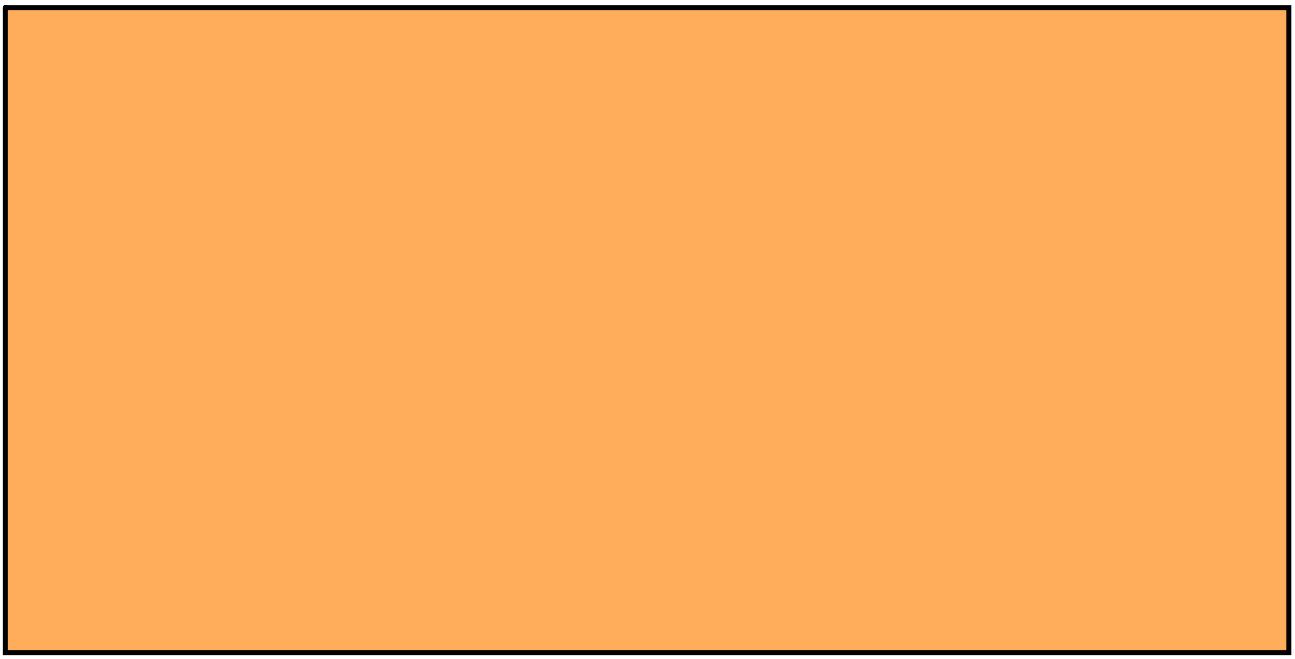
Each metal and nonmetal has been given a numerical value to indicate it's combining capacity.

Consider the following combining capacities:

- Sodium = 1
- Chlorine = 1
- Calcium = 2

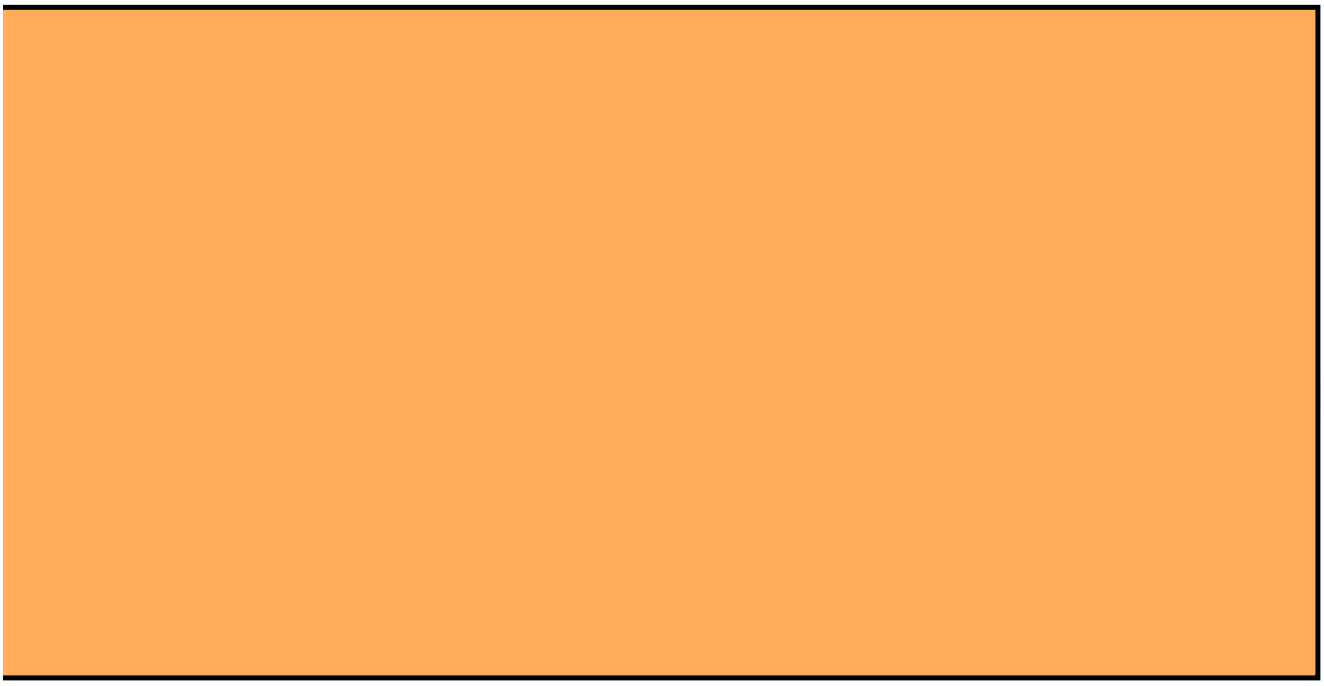
Question

How do you think sodium will combine with chlorine?



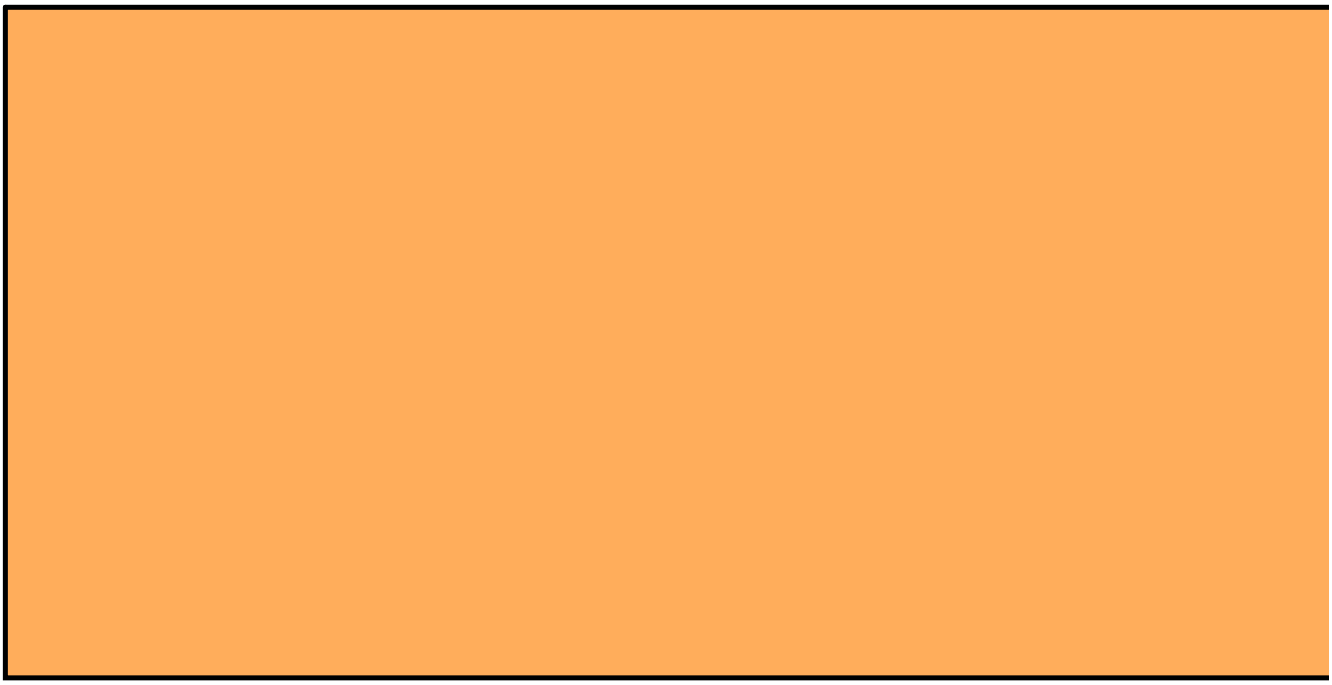
Question

How do you think calcium will combine with chlorine?



Question

How do you think calcium will combine with oxygen?

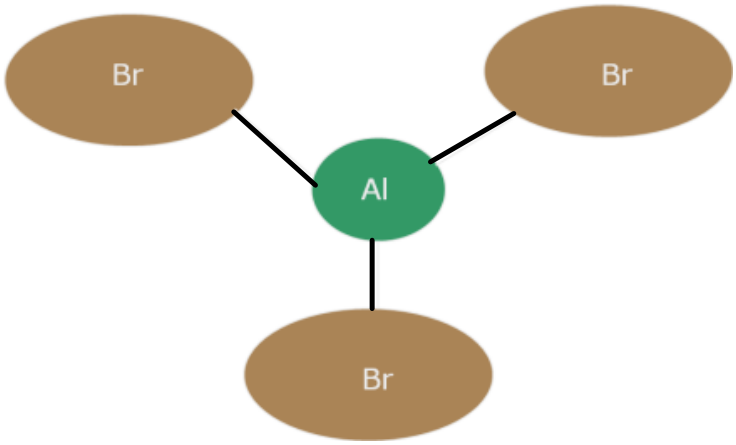


Practice

How do you think each of the following sets of elements would combine.

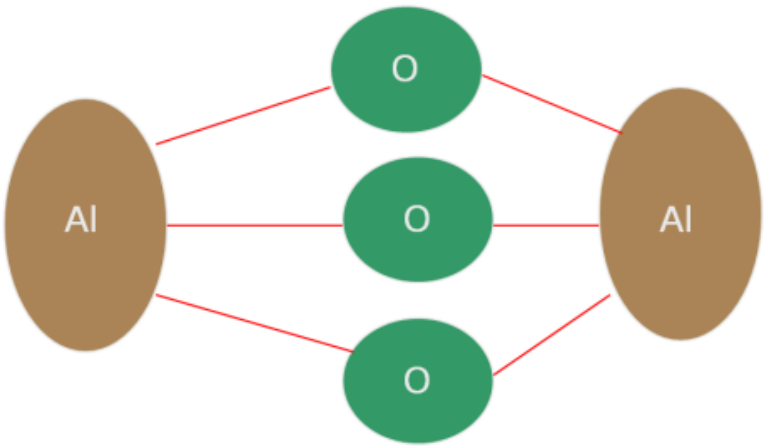
1) Aluminum and Bromine
2) Aluminum and Oxygen

Answers



Aluminum bromide $AlBr_3$

Aluminum oxide Al_2O_3



How Elements Combine Summary

1. Metals combine with nonmetals.
2. Write the name of the metal first followed by the nonmetal.
3. Change the ending of the nonmetal to "ide".
4. Each atom has its own combining capacity.
5. Atoms combine so that each one has a full combining capacity.

Homework

1. What does the term combining capacity mean?

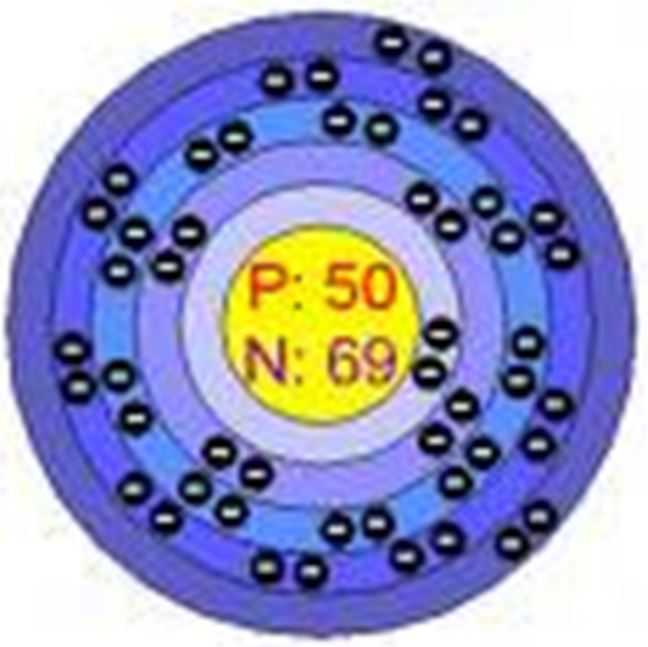
2. What are the names of the following compounds?
   a) $CaCl_2$
   b) CaO
   c) CuCl
   d) AgCl
   e) KBr

3. Draw a hook-and-ball diagram as well as write the chemical formula and name for each of the following.
   a) Sodium and fluorine
   b) Magnesium and bromine
   c) Aluminum and sulfur

Bohr-Rutherford Diagrams

Bohr-Rutherford Diagrams are pictorial representations of an atom.

Example: Tin Atom



Bohr-Rutherford Diagram Steps

1. Draw the nucleus and the first orbit.

2. Determine the number of electrons.

3. Fill the first orbit with electrons. (Maximum of 2 electrons allowed)

4. Draw the second orbit and fill it with electrons. (Maximum of 8 electrons allowed)

5. Draw the third orbit and fill it with electrons. (Maximum of 8 electrons allowed)

6. Label the nucleus with the number of protons and neutrons present in the atom.

Sample Bohr-Rutherford Diagram for Nitrogen.

1. Draw the nucleus and the first orbit.

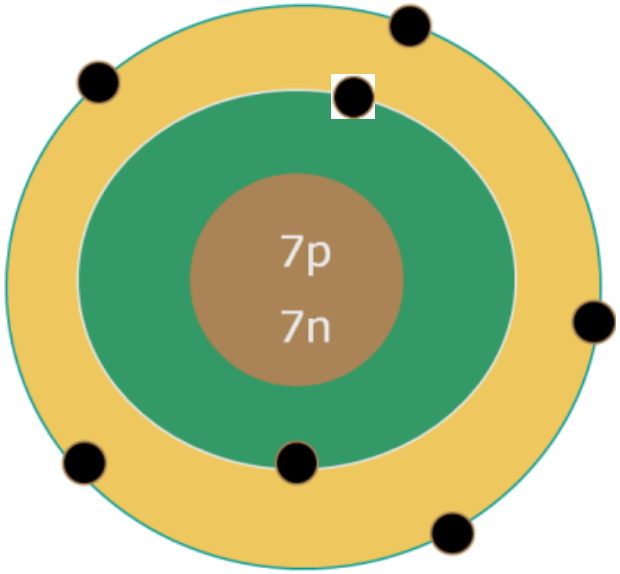
2. Determine the number of electrons. (7)

3. Fill the first orbit with electrons. (Maximum of 2 electrons allowed) (2)

4. Draw the second orbit and fill it with electrons. (Maximum of 8 electrons allowed) (5)

5. Draw the third orbit and fill it with electrons. (Maximum of 8 electrons allowed) (0)

6. Label the nucleus with the number of protons and neutrons present in the atom. (Protons = 7 and Neutrons = 7)



Practice

Create a Bohr-Rutherford diagram for Magnesiun

Practice

Create a Bohr-Rutherford diagram for Sodium.

Practice

Create a Bohr-Rutherford diagram for Neon.